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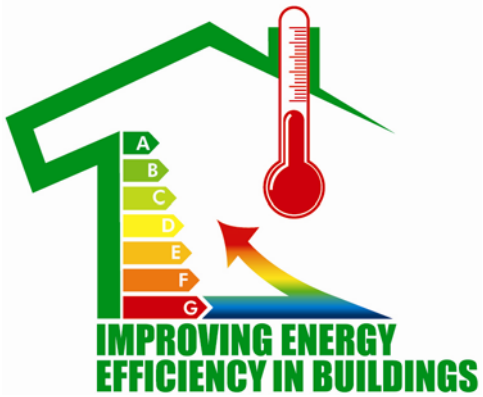
Improving Energy Efficiency in Buildings
UNDP-GEF/00059937 Project



Analytical Report

on Activities Performed in 2010 - 2011

Y E R E V A N – 2011

The present report is developed in the frames of "Improving Energy Efficiency in Buildings" UNDP-GEF/00059937 Project

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Abbreviations

CJSC	Closed Joint-Stock Company
CNM	Construction Norms Manual
EN	European Norms
EU	European Union
FCCC	Framework Convention on Climate Change
GEF	Global Environment Facility
GHG	greenhouse gases
IEC	International Electrotechnical Commission
ISO	International standard, International Standardization Organization
LLC	Limited Liability Company
MSN	Interstate Construction Norms of CIS
RA	Republic of Armenia
RACN	Construction Norms of the Republic of Armenia
RAS	Standard of the Republic of Armenia
SNiP	building codes (norms and rules)
UNDP	United Nations Development Program
UN	United Nations

Units of Measure

W	Watt
kW	kiloWatt
kWh	kiloWatt per hour
MWh	megaWatt per hour = 10^3 kiloWatt per hour
m	meter
m^2	square meter
mm	milimeter
t	ton
°C	degrees centigrade
R	thermal resistance

Content

INTRODUCTION

Pursuant to the "National Programme on Energy Efficiency and Renewable Energy" (2007) and the "RA Government Action Plan for the Implementation of the RA National Programme on Energy Efficiency and Renewable Energy" (2010) some 40% of the potential for energy efficiency is within the residential and public buildings.

The greatest potential for energy efficiency in buildings is to reduce the demand for energy for heating, which can be carried out through strengthening of the thermal protection of buildings without reducing the comfort level.

The objective of the UNDP-GEF full size project is to reverse the existing trends and reduce consumption of electrical and thermal energy and associated GHG emissions in new and reconstructed, primarily residential buildings in Armenia. This is expected to be carried out by supporting the establishment of an able regulatory environment and building professional skills and capacities, to introduce the design principles based on the energy efficiency in buildings in Armenia's construction sector, from the building design stage to construction and operation.

The project was launched in July 2010; the first year work plan was endorsed in August 2010. During the reporting period:

- The Project Steering Committee was formed, and the kickoff meeting was held;
- To support the process of implementation of activities planned under the Project, an interagency working group was established under the Ministry of Urban Development (by the Ministers Decree N125 dated 11 November 2010);
- The Project team was formed involving national and international experts from specialised organisations; and
- Close relations were established with partner organizations and regional and local programs related to issues of energy efficiency in buildings;

This report reflects the following main results of the activities planned by the 2010-2011 work plan:

- The legal and normative-technical framework related to energy efficiency in buildings field has been analysed, and recommendations have been developed to improve the field;
- Recommendations were developed on the clarification of the roles and responsibilities of the institutional structures in charge of all the phases of enforcement of the energy efficiency standards and on the development of the potential in the area of urban development;

- The capacities of the construction/insulation materials testing laboratories and certification bodies have been assessed;
- The certification procedures for the insulating materials of the buildings and the quality assurance/quality control systems in production enterprises have been analysed;
- The evaluation of the energy efficiency potential and re-design of two demo buildings has been carried out in the town of Goris and in Akhuryan community. The construction of the demo buildings has started; and
- Under the demo component of the Project a sociological research has been conducted for the assessment of the energy efficiency baseline.

1. Analysis of the Existing Legal and Normative-Technical Framework and the Institutional Structures Related to Energy Efficiency in Buildings

1.1. Legal framework

Laws

The development (revision) and localisation of energy efficency building codes and/or standards in the RA is regulated by the RA Laws "On Urban Development", "On Energy Efficiency and Renewable Energy Resources"and "On Standardisation" and the sub-legislative acts issuing from the said laws.

- The RA Law on "Urban Development", passed on 5 May 1998, establishes the fundamental provisions on urban development activities and regulates the relations associated with such activities.
- The RA Law on "Energy Efficiency and Renewable Energy Resources", adopted on 9 November 2004, is aimed at the implementation of legal, organizational, scientific, industrial, technical and economic measures in the area, the efficient use of energy resources, development of energy efficient technologies, reduction of emissions, creation and ensuring of favorable conditions for the rational use of renewable energy resources, as well as the, as well as the clear registration of produced and/or consumed energy, which will ensure the real effectiveness of energy consumption and energy saving measures.
- Pursuant to Article 6/e of this Law, the development and enforcement of energy efficiency and energy saving standardisation documents is a "tool" for the state administration of the area of energy saving. According to Article 7 of the Law, the National Standardisation Body shall, in the manner established by the RA Law "On Standardisation", adopt the energy saving national standards, which, among other requirements, shall establish the energy efficiency indicators for the technical complexes of heating, lighting, ventilation, water supply and sewerage in buildings and constructions.
- The RA Law "On Standardisation", passed on 9 November 1999, establishes the legal bases of standardisation practices in the Republic of Armenia and the competences of its participants, as well as regulates the principles for the preparation and application of standardisation normative documents.
- Article 7 of the Law establishes the list of standardisation normative documents, according to which the following shall be standardisation documents:
    - standardisation rules and guidelines;
    - national standards;

- technical conditions; and
- organizational standards.

Article 8 of the same Law stipulates that the technical regulations shall be the documents adopted by the international treaties of the RA and ratified in the manner specified by the legislation of the RA, the laws of the RA, and the decisions of the RA Government, which establish the technical requirements on entities under standardisation. Pursuant to Article 2/c, the requirements established by the technical regulation shall be mandatory.

- The RA "Law on Legal Acts", passed on 3 April 2002, defines the types of the RA legal acts and their subordination, and the general procedure for their development, expert examination, adoption, promulgation, entry into force, operation, amendment, termination, interpretation, clarification and coordination.

Normative-technical documentation

The main principles of the normative documentation system of the construction sector of the RA, the types and content of construction norms and their wording, the general requirements for their wording, as well as the procedure for their development, adoption and application are established by the construction norms RACN I-1.01-95 "System of Setting Norms and Standards in Construction".

Pursuant to RACN I-1.01-95, the existing standards in the area of urban development in the RA are as follows:

- Construction norms of the Republic of Armenia – RACN;
- Construction norms established by the USSR's GosStroy – SniP;
- Construction Norms Manual – CNM;
- Interstate construction norms – MSN;
- Collected interstate rules – CIR;
- Departmental construction norms, approved by the USSR's GosStroy: VSN, CN; and
- National (AST) and Interstate (GOST) standards.

The said documents were coordinated by the RA Ministry of Urban Development in the list published in December 2009. The list comprises 15 building complexes which currently include the basic standards below related to the energy effciency of the buildings operated in the RA:

- RACN II-7.01-96 Construction climatology (under revision);
- CNM II-7.101-98 Construction of settlements, buildings and structures under the climatic conditions of the RA;
- RACN II-7.02-95 Construction thermophysics of envelopes; design norms;
- BCM/CNM II-7.102-98 Construction thermophysics of envelopes (Manual on RACN II-70.2-95 norms/codes);

- RACN II-8.03-96 (MCH 2.04-05-95) Artificial and natural lighting;
- RACN IV-12.02.01-04 Heating, ventilation and air-conditioning
- SNiP 2.03.13-88 Floors;
- SNiP 2.08.01-89 Residential buildings;
- SNiP 2.08.02-89 Public buildings and structures;
- SNiP 2.09.04-87 Administrative and residential buildings; and
- SNiP 3.04.01-87 Insulation and decorative coatings.

The existing RACN II-7.02-95 "Construction thermophysics of the building envelopes; design norms"and the CNM II-7.102-98 Construction thermophysics of envelopes" Manual fail to comply meet the modern requirements for energy efficiency in buildings.

At present there are some 100 standards related to the energy efficiency in buildings (20 on construction glass) and some 10 technical requirements[1] for the thermal insulation materials produced in the RA.

The following international (ISO), European (EN) and CIS (MSN) construction norms and standards were localised in the RA related to the energy efficiency in buildings:

- ISO 16818 Building Environment Design. Energy Efficiency. Terminology
- ISO 23045 Building Environment Design. Energy Efficiency Assessment Guide for New Buildings
- EN 15316-1 Heating Systems in Buildings. A Method for Calculation of System Energy Demand and System Efficiency
- EN 15217 Energy Performance of a Building. Methods for Expression of Energy Performance and Energy Efficiency Certification of a Building
- EN 15603 Energy Performance of a Building. Shared Energy Use and Determining Energy Efficiency Ratings
- AST 1434-1-2010 Heat Meters: Part 1. General Requirements
- AST 1434-1-2010 Heat Meters: Part 6. Installation, Operation Delivery, Work Control and Maintenance

In 2004 the RA voted for the following ICNs adopted by the Interstate Scientific and Technical Commission for Standardisation, Technical Norms and Certification in Construction of CIS countries (МНТКС):

- MSN 2.04-02-2004 Thermal protection of buildings (under revision); and
- MSN 3.02-04-2004 Multi-apartment residential buildings.

However, these have not been adopted by the RA in national status and have not been put into operation.

[1] For more details see the respective thematic Reports.

1.2. The strategic programmes on the development of the standards in the area of urban development

Paragraph 26 of the Protocol Decision N17 of the RA Government dated 6 May 2010 approved the "Concept Paper on the System of Normative-Technical Documentation in Urban Development" which establishes the development directions of the standards system for the area of urban construction from 2010 to 2020 and includes a summary of the current issues, objectives, principles of and fundamental provisions on development of technical norms and standardisation in the area of urban development. The Concept Paper was developed based on the provisions of the "EU-Armenia Partnership and Cooperation Agreement" and the commitments of the RA for the elimination of technical barriers to trade. The concept paper serves as a basis for making of a modernised action plan for the complete system of the use of urban development norms in compliance with the international and European standards.

In 2009 the draft "2011-2013 Programme on the Priority of Harmonisation of the Existing Urban Development Norms in the RA with the norms of European Standards" was developed which was agreed upon with all interested public administration bodies and organisations. Currently it is endorsed by Para. 17 of the Protocol Decision N51 of the Government of the RA dated 30 January 2011.

In the context of the economic development of the RA, the energy sector development strategy (2005) plans the adoption of energy efficient construction norms. To fulfill the provisions of the RA Law "On Energy Efficiency and Renewable Energy", in 2007 the RA Government passed the "National Program on Energy Efficiency and Renewable Energy."

On 4 November 2010, the Action Plan for the Implementation of the National Program on Energy Efficiency and Renewable Energy was passed which also includes the improvement of the normative framework of energy efficiency in the area of urban development.

Between 15-19 November 2010, the working group of the "Improving Energy Efficiency in Buildings" UNDP-GEF/00059937 Project had several working meetings with the invited international expert, during which they discussed the existing normative-technical system of the energy efficiency of the RA urban development area and the current situation of the buildings in the context of energy efficiency, in the phases of the construction (design, expert examination, construction, technical control, supervision and operation). At the 19 November session of the permanent inter-agency working group created to assist with the implementation process of the Project activities, the international expert presented several recommendations related to the introduction of the energy efficiency norms.

1.3. Current barriers and proposed legal amendments

At present there are several hindrances in the area of development of energy efficient building codes and/or standards in the RA, of which the most important ones are as follows:

- There is a need for improvement of the legislation regulating the area of urban development, in particular, the contradictions in the provisions of the RA Law "On Urban Development" and the RA Law "On Standardisation" in terms of standardisation normative documents;
- The absence of a section in the RA Law "On Urban Development" establishing the provisions on the energy saving state policy in the area of urban development of the RA;
- The absence of the relevant requirements for energy saving in the urban development design documents;
- The absence of standardisation technical commissions for the urban development areas stipulated by the RA Law "On Standardisation";
- Low level of awareness and knowledge of designers, quality technical controllers and expert examination personnel on issues of energy efficiency; and
- The lack of a public awareness strategy on the area in question for the consumers and the general public.

1.4. Recommendations

Given the noted hindrances and taking into account the modern requirements, in order to achieve energy efficiency in buildings, it is recommended to implement the following measures.

Recommendations aimed at ensuring the application of the regulatory/normative requirements:

- To provide stricter sanctions in the RA Law "On Liability for Violations in the Area of Urban Development" for breachng the requirements of the energy efficiency norms;
- To provide the section "Energy Efficiency" in the rules endorsed by Decree N273-N of the RA Minister of Urban Development dated 29 November 2006 establishing the composition and content of the design documents of the residential, public and industrial buildings and structures'
- Develop "Energy Efficiency in Buildings" training manuals for designers, specialists carrying out expert examination, quality technical controllers and operators;

- Conduct "Energy Efficiency in Buildings" comprehensive short-term educational programs for training and qualification of designers, specialists carrying out expert examination and quality technical controllers;
- In order to familiarise the clients (developers), inform architects (designers) and specialists carrying out expert examination of the normative requirements for the energy performance of buildings; and
- Inform consumers and real estate agencies about the importance of ensuring energy efficiency in buildings. In mass media, particularly in the "Architecture and Construction" journal of the Union of Builders of Armenia and Union of Architects of Armenia, regularly insert publications on the current situation and development of energy efficiency in buildings.

The need for the adoption of new legal acts related to the area of urban development (including departmental) and the recommended amendments to the existing legal acts:

- According to the concept paper on the system of normative-technical documentation of urban development, to develop energy efficient building codes and/or standards, it is necessary to prepare and adopt:
    - The technical regulation "On Energy Performance of Buildings" in compliance with the Energy Performance of Buildings Directive 2002/91/EC;
    - The technical regulation "On Safety of Buildings and Constructions" in compliance with the Construction Products Directive 89/106/EEC;
    - Make appropriate changes to the RA Laws "On Urban Development", "On Standardisation, "On Metrology" and "On Assessment of Compliance", creating possibilities for drafting normative-technical documentation of the area of urban construction, regulation of information provision, and making a refernce in legal acts to the normative-technical documentation, introducing the international and European experience.

Amendments to the RA Law "On Urban Development"

Include the section "Energy Saving State Policy in the Area of Urban Development" in the RA Law "On Urban Development", to cover the following:

- the goal and main provisions of implementation of an energy saving state policy in the area of urban development;
- the state authority (the Government) responsible for the development of technical regulations for the energy performance of buildings, including the procedure for issuing energy passport for buildings; and

- establishing the requirements for the minimum energy performance of building under construction (based on the integrated approach); and the responsible state authority (RA Governement).

Elaboration and application of the technical regulations "Buildings and structures/premises, construction materials and products. Safety" which shall define:

- the energy performance of buildings;
- he energy efficiency requirements for buildings, and the normative basis ensuring their application;
- the procedure for organising the certification of compliance of the energy passport and energy performance of buildings and the format for the energy passport of a building;
- state control over the certification system of compliance of energy passportisation and energy performances of buildings; and
- establishing the the minimum requirements for the integrated energy performance of buildings and the state control over the safeguarding of the requirements.

Recommendations aimed at modernising the normative/regulatory requirements

It is recommended to implement the modernisation of the normative/regulatory requirements in two phases:

PHASE I:

Elaboration/localisation and adoption of the technical regulations *"Buildings and structures/premises, construction materials and products. Safety"* which will enable to introduce a precedent for the design and construction of energy efficient buildings in the RA. It will also prepare the transition to the model "technical regulations – collected rules – standards" envisaged by the "Concept Paper on the System of Normative-Technical Documentation in Urban Development" approved by the RA Government.

Localisation and adoption of interstate construction norms (ICN-EN "Thermal Protection of Buildings") revised in compliance with the EU requirements.

PHASE II:

EU Directive on energy efficiency in buildings 2010/31/EU (EPBD) has four main components.

- calculation methodology;
- minimum energy performance requirements;
- energy performance certificate; and
- inspections of boilers and air-conditioning.

The study and localisation of some 60 international and European standards ensuring their implementation by any of the approval or translation methods provided by ISO/IEC Guideline 21-2005.

As the mentioned international and European standards contain requirements established by the operating normative documents of the RA (particularly, in terms of the calculations), the necessity arises to carry out a specialised comparative analysis of the noted standards and the operating normative documents of the RA. Only based on the results of the comparative analysis it be will possible to clarify the standards that can be applied in the RA.

Recommendations aimed at promoting the construction of higher-than-the-minimum-requirements energy efficient buildings

- Recommend that the Builders Union of Armenia develop a rating system for the energy efficiency indicators of the building designs and the existing buildings for the developers, designers and building organisations. For example, establish the following nominations: "The best energy efficient building" and "The best energy efficient design".
- Promote the the construction of higher-than-the-minimum-requirements energy efficient buildings, using the successful experience of similar countries.

Recommendations have been developed on changes and additions, to include issues related to energy efficiency in buildings in the relevant RA Government decisions on the construction sector[2].

Recommendations have been developed on the clarification of the roles and responsibilities of the institutional structures in the urban development sector in charge of all the phases of enactment of the requirements of normative and legal documentation related to energy efficiency, as well as for the development of the professional potential and the provison of the technical equipment[2].

[2] The recommended changes and additions are provided in detail in the respective Report.

2. Capacity Assessment of construction and insulation materials testing laboratories and certification bodies

Capacities of certification bodies and testing laboratories per thermal-physical properties of construction and insulation materials and prefabricates were assessed, recommendations were made per selection of the Project's partner laboratories and providing technical assistance to them.

The following criteria were identified for selection of partner laboratories:

- Availability of respective accreditation in the field of assessment of thermal-physical characteristics of insulation and construction materials and prefabricates,
- Availability of measurement and testing tools and equipment,
- Availability of respective methodology and normative documents defining appropriate indicators and testing methods,
- Certification of the measurement and testing tools and equipment,
- Measurement tools being adjusted and calibrated, etc.,
- Availability of professional staff and respective experience/qualification in the processes of testing,
- Availability of quality assurance and quality control systems,
- Unbiased approach,
- Willingness for making investments and cooperation.

Respective questionnaire, prepared in advance, was sent to the certification bodies and testing laboratories accredited in the RA territory, whose activities are related to testing of thermoenergetic performance. The respondent organizations are listed in Tables 1 and 2.

Table 1. **Respondent certification bodies (CB)**

#	Title
1	"Shincertificate" LLC construction produce CB
2	"P.Abajyan" LLC produce CB
3	"Butabeton" LLC construction produce CB
4	"National Institute of Standards" CJSC produce CB

Table 2. **Respondent testing laboratories (TL)**

#	Title
1	"Ukrchin certificate" LLC TL
2	"Butabeton" LLC TL
3	"Lalvar-test" LLC construction materials TL
4	"Shincertificate" LLC construction produce TL
5	"Hayseismshin and KP Scientific Research Institute" OJSC concretes, cohesives and stuffs TL
6	"National Institute of Standards" CJSCL TL
7	"P.Abajyan" LLC produce TL
8	"Scientific Research Institute of Energy" CJSC energy measurements TL
9	"Artsakhtchan" CJSC TL
10	"Newplast" CJSC TL
11	"Institute of Mountain Metallurgy" CJSC TL

The surveys and on-site visits revealed that certification bodies and testing laboratories acting in the RA construction sector are accredited to test and certify mainly components of construction envelopes, concretes, reinforcing materials and walls. Thermal-physical properties of construction and insulation materials are not tested in practice.

Comparative analysis of the respondent laboratories in presented in Table 3.

Based on the surveys results and the on-site assessments, a recommendation was made to collaborate with "Shincertificate" LLC, "P. Abajyan" LLC and "Ukrshin" LLC as potential partner laboratories. These organizations have generally the same resources, and all of them test physical-mechanical properties of construction materials. Of thermo-physical properties, Shincertifikat and P. Abajian limited liability companies test only thermal conductivity. Both companies use БИ ТО 21А device owned by Ecoperlit LLC.

State Engineering University of Armenia also possesses laboratory equipment for assessment of heat conduction. The equipment is of no practical value however, as it is of limited capacities and is not calibrates. Nevertheless, expertise of the University may be used.

In comparison with insulation materials and prefabricates, the case of windows and doors the situation is less satisfactory in terms of conducting testing based on existing methodologies and of certification. There is no laboratory in Armenia able to conduct assessment of thermal conductivity, vapor permeability, vapor permeability, transparency of window frames (GOST 26602.1-99, GOST 26602.2-99, GOST 26602.4-99).

"Shincertificate" LLC, "P. Abajyan" LLC and "Ukrshin" LLC are willing to make certain constributions into testing thermal-physical properties of materials and prefabricates as well as into procurement of measurement equipment.

Table 3. **Comparative analysis of the respondent testing laboratories**

Criterion	Organization										
	"Shincertificate" LLC TL	"P.Abajyan" LLC produce TL	"Lalvartest" LLC TL	"Hayseismshin and KP SRI" OJSC	"Butabeton" LLC TL	"National Institute of Standards" CJSCL TL	"Artsakhtchan" CJSC TL	"Scientific Research Institute of Energy" CJSC TL	"Newplast" CJSC TL	"Institute of Mountain Metallurgy" CJSC TL	"Ukrchin certificate" LLC TL
Accredited to assess thermal-physical properties of construction and insulation materials and prefabricates	+	+	-	-	-	-	-	-	-	-	-
Possesses the respective testing equipment and measurement devices	Physical-mechanical*	Physical-mechanical*	Physical-mechanical	Physical-mechanical	Physical-mechanical	–	Physical-mechanical	-	-	-	Physical-mechanical
Possesses the normative documentation on tesing methods and assessment of respective indicators	+	+	+	+	+	+	+	-	-	-	+
Measurement methods and testing equipment attested	By sector**	By sector**	By sector**	By sector**	-	-	By sector**	-	-	-	By sector**
Measurement devices calibrated	Yes	Yes	Yes	Yes	Yes	-	Yes	-	-	-	Yes
Has respective qualified specialists	By sector**	By sector**	By sector**	By sector**			By sector**	-	-	-	By sector**
Introduced quality control and assessment system	+	+	+	+	+	+	+	-	-	-	+
Works without bias	+	+	+	+	+	+	+	-	-	-	+
Accredited as a certification body	+	+	+	-	+	+	-	-	-	-	-
Response to cooperation proposal	+	+	+	-	-	+	-	-	-	-	+

* On contract basis, laboratories use БИ ТО 21А device that belongs to "Ecoperlit" LLC to assess heat conduction of homogenous insulation materials

** Experts of TL are qualified in physical-mechanical testing

*** Experts of TL are qualified in thermal insulation materials testing

In the frames of the Project, the following technical assistance is recommended for the selected partner laboratories.

1. It is suggested to purchase and provide one of the following devices for thermal conductivity measurement:
   - **ПИТ-2.1.:** It is designed for determination of thermal conductivity of insulation and construction materials under stationary thermal regime according to the requirements of GOST 7076 (http://www.iztech.ru/goods/26/),
   - **QUICKLINE TM-30 THERMAL PROPERTIES ANALYZER**: It is designed for measurement of thermal conductivity, volumetric heat capacity and temperature of construction materials. It tests thermal insulation of buildings and pipelines. It is applicable during optimization of insulation materials manufacturing (http://labtest.su/equipment/list-thermo-analysis/folder-10/goods-uickline30.html),
   - **ИТП-МГ4.03 "ПОТОК"** device for measurement of thermal conductivity. It is designed for measurement of thermal conductivity of construction elements and insulation materials. It is possible to measure the thermal conductivity coefficients of GOST 26254 and 26602.1 for windows and doors (http://www.shop.iscgroup.ru/index.php?categoryID=160&offset=8);

2. Acquisition and provision of a chamber for climatic testing of windows and doors units (in line with State Standard GOST 26601.1-99 “Windows and doors units: Methods for determining heat transfer resistance”);
3. Organization of a study tour to an Eastern European country;
4. Development and provision of instructional and training materials (books, DVDs, testing methodologies, pictures, etc.);
5. Organization of professional development courses for the laboratories personnel with involvement of local and international experts. Topics to be studies are as follows:
   - fundamentals of materials’ thermal-physical characteristics,
   - conformity assessment procedures,
   - requirements presented to certified testing laboratories and conformity assessment procedures,
   - measurement parameters of measuring devices and analysis methods of measurement results,
   - contemporary research methods for thermal-physical measurements.

3. Analysis of building insulation materials certification procedure assessment and quality assurance/quality control systems in production facilities

Currently certification of building insulation materials is carried out in accordance with the RA Law "On Compliance Assessment", decisions of the RA Government and the national standards establishing the certification procedures. In the result of the certification, the applicant is issued a document – a compliance certifficate (for a period of up to three years) – certifying the compliance of the product with the set requirements.

Certification of compliance of building insulation materials and products is voluntary; therefore it is carried out not in accirdance with the technical regulations but at the applicant's discretion, under the terms and conditions of the contract between the latter and the certification body. The construction materials and products produced in the RA and those imported are rarely certified by the energy efficiency indicators and are not labellefd by their thermal-technical quality.

There are many problems in the urban development sector of the RA: the costs for enhancing energy efficiency are being reduced to decrease the cost of construction; the legislative requirement for the expert examination of energy efficiency of the designs is not being met, etc.

The technical terms, key characteristics and the classification of the thermal insulation materials, envelopes and products established by the respective standards, the procedures for deriving the energy-efficiency-related indicators and the calculations, quality assurance and quality control methodologies and the testing methods are available in and are provided by GOST 16381-77, GOST 17177-94, GOST 7076-99, GOST 30256-94, GOST 30290-94, GOST 25380-82, GOST 26254-84, GOST 31166-2003, GOST 23166-99 and other standards.

The certification bodies and testing laboratories accredited in the RA can perform certain tests, however, for the measurement of the main energy efficiency indicator of thermal insulation materials – the thermal conduction coefficient, there is only one calibrated piece of equipment: БИТ-021А, which, however, can not be used for all insulation materials. There is also another piece of equipment manufactured in 1965, which is used for training purposes only. Due to the lack of demand, it is used for 3-4 testings annually, and the new equipment is costly and inexpedient to acquire.

The situation of products – windows and doors – is even worse in terms of certification and testing on the basis of the existing methodologies. Currently there is no laboratory in Armenia which has the capacity to determine the window blocks' heat conduction resistence, air, water and light penetration (GOST 26602.1- 99, GOST 26602.2-99, GOST 26602.4-99).

Thermal insulation materials and products manufacturing enterprises often simply present, as the technical specificataions of their own products, the certificates other similar products, and, at best, have their products certified according to the technical terms (RATT), including only a few basic specifications: density, the compression strength under 10 % linear transformation, the limit of stretching strength, water absorbtion and heat conductivity.

The procedures for certification of compliance of the building insulation materials and products and the methodology for the energy-effciency-related indicators are in place, but, according to respective GOSTs, their certification or quality control is currently technically impossible to carry out in the RA.

Quality control is carried out in the production units only visually – approximate verification of the size, appearance, weight and form. Due to the lack of the analysis of production situation, quality assurance and management systems (GOST 26281-84), (there are no simple measurement and monitoring tools and equipment) the local producers of thermal insulation materials and products cannot meet the quality assurance and quality control requirements in the production units: testing and control of product transfer and acceptance, regular testing, maintenance, inspection and evaluation of equipment and process management system, documentary confirmation of the quality of the accepted batch of production, etc. Certification and testing of thermal insulation materials and products are handled by certification bodies and testing laboratories accredited in the area of building materials and products, yet the equipment of the latter do not enable to do all the testings required by the existing standards.

The main hindrance to the certification of thermal insulation materials and products, and the development of the area of testing is the lack of business environment, which is conditioned by the scarcity of the market demand, the latter in turn being the result of the following circumstances below:

- construction is carried out by traditional methods; energy efficiency measures are mostly not applied;
- during the design and construction of buildings the requirements of RACN II-7.02-95 “Construction thermophysics of the envelopes; design norms” are not being met. These are ignored mainly through the wim of the client, for financial or other reasons;
- there is no mechanism in place for energy efficiency certification or passportisaton of buildings;
- the price on natural gas in the RA is still lower compared to international prices (also there is a differentiation procedure for the natural gas tariff depending on the

volume of consumption), and the implementation of energy efficiency measures is not encouraged;

- the difficult socio-economic condition of the Armenian Republic (budget scarcity, high poverty level) leads to a situation where saving is preferred to energy efficiency measures, at the expense of lowering the level of comfort;
- thermal insulation materials and products are not on the list product and service subject to mandatory compliance certification established by technical regulations;
- there are no statistical data on energy consumption in buildings;
- there are no mechanisms for promoting the enactment of legislation (laws, standards, norms) establishing the requirements for energy-efficient construction; and
- there is no culture shaped in the country for fighting environmental pollution, for environmental protection and energy efficiency, for priding on the emissions reduction and using incentives, no leadership of energy and environmental design, as in many developed countries.

The creation of a business environment is the main prerequisite for the promoting the process of certification of materials and products ensuring the energy effciency of buildings, and for operating the quality control systems in manufacturing enterprises.

To assist with the solution of these problems, the following is proposed under the "Improving Energy Efficiency in Buildings" UNDP-GEF/00059937 Project (as possible):

- to assist with the selective certification of the production of the enterprises producing insulation materials and products in the RA by domestic/foreign certification bodies and testing laboratories;
- develop a voluntary labeling system related to energy efficiency of insulation materials and products; and
- develop a guide on calculation and documentation (measuring, controlling, inspection, approval and validation) of energy efficiency in buildings [(M & V) Guidlines].

The targeted and various measures implemented under the Project must result in the establishment of an environment and creation of conditions to make energy-efficient construction beneficial for the developer and the client alike. This will in its turn motivate to use reliable and certified building insulation materials and products during the construction/reconstruction of buildings. The latter will promote the processes of establishment and improvement of certification activities in the certification bodies and testing laboratories of the RA and the quality assurance and quality control systems in local production enterprises.

4. Demonstration (pilot) projects of improving energy efficiency in buildings

4.1. Objective of the Demonstration Projects

In the frames of the Project, it is envisaged to demonstrate advantages of integrated buildings design approach via its application to selected pilot multi-apartment buildings.

Improvement of energy efficiency in buildings pursues a number of practical goals: improvement of indoor comfort, saving of fuel and energy resources (natural gas and electricity), meeting requirements of environmental protection, thermal insulation and soundproofing, and decrease in operation costs.

The demonstration buildings were selected according to the following criteria:

- Project replicability
- Socially oriented multi-apartment buiding construction
- Participation of the State as the warrant of the construction implementation

Based on the criteria listed above, two projects were selected:

- Multi-apartment building in Akhuryan community, construction in the frames of "Apartment construction with support of the State to provide housing to the families deprived of homes by the earthquake in residential areas of the disaster zone" program,
- Social multi-apartment building in Goris town, construction financed by Swiss Development and Cooperation Agency and the RA Government.

Architectural solution options for application of new approaches to meet the building thermal protection requirements in design and construction shall be demonstrated and economic feasibility of their application assessed in the instances of the selected buildings.

During discussions with the Project's stakeholders, a number of constrains were revealed, that are demonstrated in the table below.

Table 4. **Selection process of energy efficiency measures to be applied to the demonstration buildings**

N	Pre-requisites	Comments
1	Replication potential	The applied approaches must ensure easy replication
2	Affordability	The applied technologies must be available in Armenia's markets and affordable
3	Constrains per the changes in the bearing constructions (seismics)	Amendments envisaged must not affect adversely the seismic indicators of the buildngs
4	Apartment areas must not shrink as a result of amendment of the building's baseline design	Decrease in apartment area as a result of energy efficiency improvement measures is not allowed in the pilot builidngs

4.2. Demonstration Building in Akhuryan Community

In the frames of the reconstruction program of the RA Government in the areas that suffered from the earthquake in 1988, so far 22 builidngs are constructed in Gyumri city and another 38 are upcoming. "Glendale Hills" CJSC is responsible for the construction, while design is performed by "Domus Design" and "Architon" companies.

Approach to the works' implementation was based on supplementing/amending the existing design so that it would be in line with MSN 2.04-02-2004 "Thermal Protection of Buildings" and RACN II-7.02-95 "Thermal Physics of Building Envelopes".

The builidng constructed according to the new design would ensure not only significant reduction of heating costs for the residents, but also feasible amounts and economic efficiency of investments into thermal insulation.

The selected demonstration building is a new, four-storey multi-apartment residential building to be constructed in the frames of State housing program for the families deprived of homes by the earthquake in Akhuryan community of Shirak region. The building is of 4A-type design envisaged for "Mush-2" residential area in Gyumri city. 12 of those are under construction in "Mush-2" and another 3 – in Akhuryan community. One of the latter is the selected demonstration building that will be constructed with application of energy efficiency technologies.

Model view of the demonstration building

- type of the bulding: 4a
- total area: 2242 m^2
- apartments: 36
- storeys: 4
- entrances: 3

Baseline design

External walls: three-layer made of 200mm- and 100mm-thick reinforced concrete blocks. Vacancy between the layers (100 to 150mm) is filled with volcanic slag.

Windows and external doors (of balconies and entrances): 6 cm-wide metal-plastic frames, two-layer glazing, local production.

The first storey's floor: no insulation envisaged.

The highest storey's floor: thermal insulation with 300mm-thick slag is envisaged.

Walls in the baseline option

External columns and beams: no insulation envisaged.

Balconies: no insulation is envisaged for concrete blocks.

Vestibules (tambours): not envisaged.

Based on the design data, average of thermal resistances of walls, covers, floors and windors were estimated. The resulting values are significantly lower than those identified by the norms.

Proposed (project) option

Based on the contract signed with the Project, "Architon" LLC performed a re-design of the 4A-type builidng, guided by design task prepared by the expert team of the Project. The task included energy efficiency improvement measures to eb performed in the building (trhermal insulation of the building envelope, replacement of the doors and windows, introduction of the tambours).

Study of the locally available insultaion materials and prefabricates from "price to thermal resistance" viewpoint showed that the most competitive optionc are those of polysterene sheets and of polyurethane blown on the constructions directly, on the site.

Detailed estimations demonstrated that the latter one is preferable (due to applicability of the technology and possibility to abide by the design as required as well as availability of the respective certificates). Advantages and disadvantages of the considered options are demonstrated in the Annex 2.

The re-design of the building is as follows.

Thermal insulation of the external walls

External walls

- For the external walls, Φ8 A500C reinforcement rods are put through 200mm-thick reinforced concrete blocks at 40 by 40cm to be further fixed to the reinforcement mesh.
- From the outside, the blockwork is covered with 80mm-thick on-site blown polyurethane (-0.36 point to 12.04 point).
- The polyurethane layer is covered with concrete cohesive.
- Metallic mesh (with 100mm by 100mm cells) is fixed to the reinforcement rods.
- The external surface is plastered with concrete-sand mix and coated with tuff tile slab selectively.
- The 100mm reinforced blockwork from the inside and thermally insulating slag are removed from the baseline design, and the wall of 200mm-thick reinforced concrete blocks is plastered with gaj from the inside.

The first layer's floor (0.00 point)

- 60mm-thick polyurethane layer is blown under the block (-0.30 point) of the first layer (0.00 point) and on the beams.
- The polyurethane surface is covered with concrete cohesive.

- The plastic mesh is fixed to the floor's block and the beams with dowels.
- The surface is plastered with gaj.
- To perform the respective works and ensure proper operation below the 0.00 point, vestibules (tambours) are envisaged in the stairways sections with metallic doors and metallic stairs.

The highest storey's cover (12.00 point)

- 105mm-thick polyurethane layer is blown over the fourth floor's cover.
- The polyurethane surface is covered with 50mm-thick concrete-sand smoothing mix.
- Vapor-insulating layer of the 12.00 point is removed form the baseline design.

Balconies

- Thickness of the reinforced concrete blocks decreases by 80mm.
- External surface of the balconies is covered with 20mm-thick polyurethane layer.
- The polyurethane surface is covered with concrete cohesive.
- Metallic mesh is fixed to the balconies' blocks with dowels.
- The surface is plastered with concrete-sand mix.

Doors and windows

- Doors and windows with metal-plastic five-aperture frames with three-layer glazing (4 – 12 – 3 – 6 – 4).
- External doors and windows are thermally insulated with rock wool by their perimeter.

Vestibules (tambours)

- Vestibules (tambours) are envisaged for all the entrances of the building.
- Vestibules of side sections of the building are envisaged under the stairway landings.
- Vestibule of corner section of the building takes a part of a three-room apartment.

Common walls of the three entrances and apartments are implemented as follows:

- 100mm-thick light concrete blockwork with reinforcement rods put through.
- The resulting wall is covered with 70mm-thick polyurethane layer from the vestibule's side.
- Metallic mesh is fixed to the vestibule's wall with dowels.
- The polyurethane surface is covered with concrete cohesive.
- The surface is plastered with concrete-sand mix, then with gaj selectively.

Construction of the Demonstration Building

The 100mm concrete blockwork and thermally insulating slag are removed from the walls between the building's sections.

Stairway-wise constructed shafts for natural gas pipes and meters must have hermetically closing metal-plastic doors and reflectors installed according to the safety requirements.

Due to changes applied to the external walls of the building, areas of the apartments increased compared to the baseline design. Total living space of the building increased by 90 m^2. Due to ligher external walls, mass of the building decreased thus decreasing the effect of seismic powers and the bearing constructions are under lower pressure, so their relyability is higher.

Values of thermal resistance of the building envelope, energy and economic indicators per the baseline and the proposed designs are shown in Tables 5, 6 and 7.

Table 5. ***Comparison of thermal resistance indicators of the building envelope***

Building envelope	Thermal resistance (R), $m^2 \cdot °C/W$	
	Baseline option	Proposed option
Walls	0.72	3.10
Windows	0.38	0.51
Floors of the first storey	0.79	3.11
Covers of the last storey	0.85	3.93

Table 6. **Comparative assessment of estimated energy indicators**

Indicator	Baseline option	Proposed option
Internal air temperature, °C	+20	
Energy performance, kWh/m^2year	203	65
Thermal loading of the building, kW	240	74
Natural gas consumption with heating purposes, m^3	49000	15700
Emissions of greenhouse gases, t	92	29,5
Additional total area, m^2	-	91

Table 7. **Difference in costs of the baseline and proposed options by the building component**

Component	Construction costs, thousand AMD		Difference, thousand AMD
	Baseline option	Proposed option	
Walls	51,806	43,737*	**-8,069**
Covers	-	10,933	**10,933**
Reinforced concrete constructions	2,040	8,857	**6,816**
Windows and doors	13,905	21,461	**7,557**
Total	**-**	**85,969**	**18,218**

** Note: Solution for the walls is less expensive than in the baseline design.*

Increase in the applied costs per 1 m^2 of the construction is about 8,500 AMD. Value of the building will go up by about 6%.

4.3. Demonstration Building in Goris town

In the frames of the Swiss Governments' donor concept on providing housing to socially vulnerable families, "Mastara" PC developed design documentation and estimates for residential building to be constructed at 151 Mashtots street in Goris town.

The building consists of two sections designed with reinforced concrete envelope, unregular blockwork and stone-concrete external non-carrying walls. Interfloor covers are of round cellular reinforced concrete blocks.

Approach to the works' implementation was based on supplementing/amending the existing design so that it would be in line with MSN 2.04-02-2004 "Thermal Protection of Buildings" and RACN II-7.02-95 "Thermal Physics of Building Envelopes".

The builidng constructed according to the new design would ensure not only significant reduction of heating costs for the residents, but also feasible amounts and economic efficiency of investments into thermal insulation.

Residential building to be constructed at 151 Mashtots street in Goris town was selected as the baseline.

The baseline building is a construction of four floors, two blocks sections. The carcass of the building is of reinforced concrete and covers – of round cellular reinforced concrete blocks. External walls are of locally produced basalt with village-type and ashlar coating on stone-concrete blockwork, with thickness of 50-70 cm. Roof will be covered with vapor-insulating ruberoid and 80mm-thick slag layer for thermal insulation.

Baseline option

External walls: of locally produced basalt with village-type and ashlar coating on stone-concrete blockwork, with thickness of 500 to 700 mm.

Windows and external (balcony and entrance) doors: 6 cm-wide metal-plastic frames, two-layer glazing, local production.

First storey's floor: 60mm-thick slag-concrete and 20mm smoothing layer.

The highest storey's cover: vapor-insulating ruberoid and 80mm-thick slag layer for thermal insulation.

Model view of the pilot building

External walls and beams: no insulation envisaged.

Balconies: no insulation envisaged for concrete tile slab.

Vestibule (tambour): not envisaged.

Based on the design data, average of thermal resistances of walls, covers, floors and windors were estimated. The resulting values are significantly lower than those identified by the norms.

Building state as of September 2011

Proposed (project) option

Based on the contract signed with the Project, the architect of "Mastara" PC performed a re-design of the builidng, guided by design task prepared by the expert team of the Project. The task included energy efficiency improvement measures to eb performed in the building (trhermal insulation of the building envelope, replacement of the doors and windows, introduction of the tambours).

Due to architectural solutions applied in the building, thermal insulation of the external walls may be performed only from inside.

The re-design of the building is as follows.

External walls

Insulation of the walls

- Coating of the external walls of the building is the same: village-type blockwork of 12 to 15 sm thickness and carcass is made of light B7.5 brand reinforced concrete with Φ8 A500C reinforcement rods, and the metallic mesh to be further fixed using light blockwork from the inside.
- External walls are covered with 60mm-thick polyurethane layer from the inside, from 0.00 to 9.00 point.
- Over the polyurethane layer, light 100mm-thick blockwork comes with gaj plastering from the inside.
- External walls with open balconies are made of 100mm-thick blocks that are thermally insulated from the outside with 60mm-thick polyurethane layer and fixed with metallic mesh.
- Surface of the polyurethane is coated with concrete cohesive.
- Metallic mesh (with 100 by 100 cells) is fixed to reinforcing rods.
- External surface is plastered with concrete-sand mix.

Covering of the wall insulation with blocks

The first storey's floor (0.00 point)

- On the block (-0.08 point) and beams of the first storey's floor (0.00 point) a 40mm-thick pplyurethane layer is blown.
- Unlike the baseline design, the floors' concrete-sand smoothing layer is 40mm-thick (instead of 20mm) and reinforced with metallic mesh (with 100 by 100 cells).

The highest storey's cover (12.00 point)

- Over the third floor's cover (9.00 point), 60mm-thick polyurethane layer is envisaged.
- The surface of polyurethane is covered with 40mm-thick concrete-sand smoothing layer.

Balconies

- External surface of reinforced concrete blocks of the balconies is covered with 20mm-thick polyurethane layer.
- Surface of the polyurethane is coated with concrete cohesive.
- The metallic mesh is fixed to the balconies' blocks with dowels.
- External surface is plastered with concrete-sand mix.

Doors and windows

- Doors and windows with metal-plastic four-aperture frames with two-layer glazing (4mm by 12mm by 4mm)
- Thermal insulation of external doors and windows with rock wool by their perimeters.

Insulation of the floors

Vestibules (tambours)

For walls of two entrances and common walls of certain apartments:

- Ligh 100mm-thick blockwork with incorporated reinforcing rod to further fix the metallic mesh.
- Vestibule (tambour) for main entrances thermally insulated from outside with 60mm-thick polyurethane layer.
- Surface of the polyurethane is coated with concrete cohesive.
- Metallic mesh with 100 by 100 cells is fixed.
- Plastered with concrete-sand mix.

The roof is thermally insulated in stairway section with 60mm-thick polyurethane layer ensuring the stairway thermal resistance.

Due to changes applied to the external walls of the building, areas of the apartments increased compared to the baseline design. Total living space of the building increased by 23 m^2. Due to ligher external walls, mass of the building decreased thus decreasing the

effect of seismic powers and the bearing constructions are under lower pressure, so their relyability is higher.

Values of thermal resistance of the building envelope, energy and economic indicators per the baseline and the proposed designs are shown in Tables 8, 9 and 10.

Table 8. ***Comparison of thermal resistance indicators of the building envelope***

Building envelope	Thermal resistance (R), $m^2 \cdot °C/W$	
	Baseline option	Proposed option
Walls	1.03	2.65
Windows	0.38	0.46
Floors of the first storey	0.54	1.78
Covers of the last storey	0.54	3.07

Table 9. **Comparative assessment of estimated energy indicators**

Indicator	Baseline option	Proposed option
Internal air temperature, °C	+20	
Energy performance, kWh/m^2year	152	85
Thermal loading of the building, kW	74	38
Natural gas consumption with heating purposes, m^3	11700	6500
Emissions of greenhouse gases, t	22	12.2
Additional total area, m^2	-	23

Table 10. **Difference in costs of the baseline and proposed options by the building component**

Component	Construction costs, thousand AMD		Difference, thousand AMD
	Baseline option	Proposed option	
Walls	15 453,07	21901,30	**6448,23**
Covers	2 596,00	7182,38	**4586,38**
Reinforced concrete constructions	198,45	2351,35	**2152,90**
Windows and doors	8 956,09	10589,53	**1633,44**
Total	**27 203,61**	**42024,56**	**14 820,95**

Increase in the applied costs per 1 m^2 of the construction is about 16,000 AMD. Value of the building will go up by about 8%.

5. Sociological Study of Energy Efficiency Situation in Newly Constructed Multi-apartment Buildings in Shirak Region of the Armenia, city of Gyumri, "Mush-2" district

5.1. Background

It is planned to construct a multi-apartment residential building in the earthquake-affected area in Armenia with the support and co-funding of UNDP-GEF Project "Improving Energy Efficiency in Buildings" (hereinafter the Project) aiming to demonstrate potential for energy saving and cost-effectiveness in an integrated building design. The demonstration building was selected in Akhuryan community and agreed with the RA Ministry of Urban Development.

A multi-apartment inhabited residential building in Mush-2 district

Taking into consideration that the construction of the demonstration building planned in Akhurian village should be implemented with application of the same technology and of the same building envelope as in the city of Gyumri, the social survey was conducted in 5 newl constructed multi-apartment buildings of "Mush-2" district of Gyumri.

As of March 2011, construction of 38 buildings was completed. Most of those buildings are already occupied by residents, including socially vulnerable families.

For the works to be performed by the Project, it was necessary to collect relevant information on the newly constructed buildings, study the residents' opinion and approaches to energy efficiency issues in the newly constructed buildings.

Noteworthily, 2010-2011 heating season was the first for these buildngs and collection and analysis of the data allows receiving actual data on energy efficiency situation in the buildings.

At the same time, the acquired data and main findings of its analysis would be useful for the further deisgn and construction of the demonstration building in Akhuryan community.

The social survey was conducted by "Third Nature" non-governmental organization.

Information was collected by method of inquiry among residents. The survey was carried out in

Model view of buildings in Mush-2 district

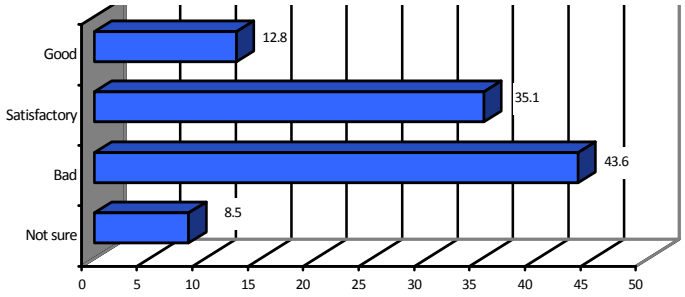
94 apartments of 5 newly constructed buildings in Mush-2 district (the total number of apartments in those buildings is 204; of those, 134 were inhabited during the 2010-2011 heating season).

Besides, for comparison of certain data, interviews were held in 22 apartments of an old building in the district (the total number of apartments in the building is 56; of those, 39 were inhabited during the 2010-2011 heating season).

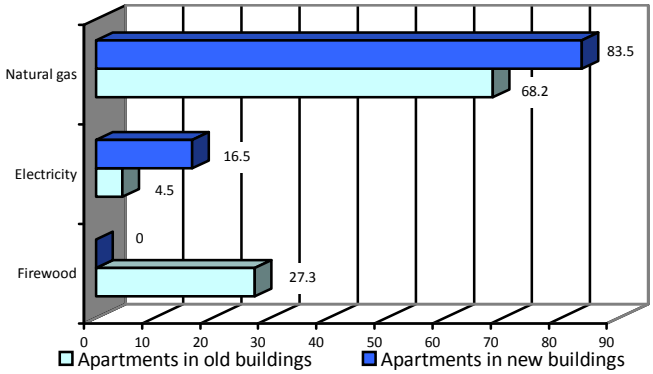
5.2. Main findings

The analysis of the conducted survey gives ground to make the following main conclusions:

- All together, shares of the responses assessing the construction quality of the buildings as *good* (about 12.8% of the respondents) and *satisfactory* (35.1%) slightly exceed that of the responses assessing the construction quality as *bad* (43.6%).



- The main reasons for discontent were dampness of walls (46.8%), windows (60.6%) and ceiling (18.1%), while in relation to the heating system – uneven heating of apartments (23.1%).
- In 22.3% of the apartments, residents made repairs or renovations to improve energy efficiency. Those activities aimed for the most part at renovating the heating system (33.3% of all activities) as well as changing the place of a boiler (also 33.3%). The share of the repairs to windows, plastering of walls and adding of radiators is smaller (10%-14%).
- Initially individual gas boilers were installed in the apartments. Nevertheless, 16.5% of the newly-constructed apartments were heated using electricity. All other apartments (83.5%) were heated using natural gas, with 78% of the apartments heated by an installed local-individual gas boiler, while in a small percentage (5.5%) of the apartments gas stoves were used. In old apartments in the same district firewood is used quite widely (27.3%).



- Satisfaction of residents of newly built apartments with the heating system is at a high level: 29.7% are satisfied and 54.9% are satisfied partly. The main reasons of discontents are a fee to be paid for the used natural gas (64.9%) as well as insufficient number of radiators and absence of radiators in the apartment corridor (uneven heating) (23.1%).
- In case of about 11% of the apartments with heating not the entire apartment is heated. 60% of those apartments are one-room apartments and the families that live in them are extremely socially vulnerable. The families heated only the kitchen or the room in the apartment. The average heated surface area is 51 square meters per apartment.
- During the heating season the temperature in various apartments ranged from 7°C to 24°C. The prevalent temperatures are 17-18°C (40.7%) and 15-16°C (28.6%). The temperatures measured in staircases were always above zero.
- The average length of a heating season was 5.3 months, with the most common daily length of heating ranging from 3 to 12 hours.
- In newly-constructed buildings, water for household use is heated primarily with local-individual gas boilers (86.2%), whereas in the old building, heating water on a gas stove is more widely used (45.5%).
- An average monthly consumption of gas in newly-built apartments during a heating season is about 1.5 cubic meters per square meter of the surface (198 AMD per square meter), whereas in case of electricity the consumption was about 2.45 kWh per square meter (73.5 AMD per square meter). An average monthly bill for gas was over 10,000 AMD and for electricity was about 3,800 AMD per 1 apartment (average heated area of 51 square meters).
- The single type of heating most favored by residents was a local-individual gas boiler (86.2%). The two most-often stated reasons were possibility to regulate temperature at will as well as clean and safe heating.
- Residents in newly-built apartments regarded installation of better-quality doors and windows (26.6%) and increasing the number of radiators and placing them in the apartment corridor (17%) as a main strategy to cut heating expenses. Residents in the old building regarded as important thermal insulation of their apartments (31.8%), installation of better-quality doors and windows (50%) and especially the problem of thermal insulation of staircases and entrances (90.9%).

5.3. Recommendations

- It is advisable that the heating system should be designed in line with the principle of even heating of the apartment. The residents' actions of moving the boilers and building separate chimney flues should be prohibited. It is suggested to consider options for improvement of work of the central chimney.

- It is recommended to give preference to a central heating option at the demonstrative buildings' technical design and construction stages in energy efficiency projects for multi-apartment buildings and to underscore all the advantages of that system. At the same time, choosing the option of central heating rests on the idea that residents make collective decisions, which can provide an impetus to management and use of the building on the basis of new, efficient principles of common share ownership.
- It is recommended to make an energy-efficiency assessment and comparative analysis of multi-apartment buildings in Akhurian, where it is planned to undertake an integrated building design and construction of a demonstration energy efficient multi-apartment building with the support from the Project and in existing buildings of the same type in Gyumri.
- The use of the analytical computer software will make it possible to develop mini business projects, which will aim to improve energy efficiency of the existing multi-apartment buildings in the community and which will need funding as small as possible, while at the same time entailing significant positive results and a short pay-back period. The local self-government bodies will get an opportunity to consider the community potential to implement those projects, including loan resources attraction and residents' participation.

6. Awareness raising, training and organisation of educational programs on builidng design based on the principles of energy efficiency

A roundtable discussion on the energy efficiency in buildings was held in the Union of Builders of Armenia. The discussion was attended by the well-known experts of the sector, the representatives of the Ministry of Urban Development and the UNDP/GEF Project and the ESIB Regional Project experts. A resumé was prepared on the issues of energy efficiency, the UNDP/GEF Project and its objectives and actions, which was imprinted in the "Architecture and Construction" journal published by the BUA.

The sociological survey conducted in the "Mush-2" district of the town of Gyumri in the framework of the Project revealed a need for public awareness on the issues of energy efficiency. To this end the information brochure "Let us Save Energy: Instructions for Energy Saving and Energy Efficiency in Multi-Apartment Buildinds" was developed. Explanatory meetings were organised with the residents of the newly built buildings during which the instructions above were presented and clarifications were provided.

The activities aimed at development/amendment of training courses and educational programs on energy efficiency in buildings have started with the involvement of local and international experts.

For public awareness raising and sharing of experience on energy efficiency in buildings, new buildings were studied in Yerevan in order to find the best examples.

The study resulted in the assessment of the energy consumption and energy saving performance of the buildings, principles and criteria were developed for the rating system of the buildings by the energy efficiency, and recommendations were made, in order to provide technical assistance for the developers or the owners of buildings with higher energy efficiency indicators on the evaluation of the parameters of the buildings.

- The study shows that only in some of the new buildings the envelopes are thermally insulated. Foam plastic, glasswool, foam polystyrol, perlite slabs and mortars/fillers with powdered perlite are common as insulators. In several buildings studies the requirements of RACN II-7.02-95 are met.
- In the new buildings primarily metal-plastic windows and balcony doors are designed (6 cm-thick profiles, 4 chambers, two-layer glazing) or aluminum profile (with a thermal bridge). However local and foreign manufacturers alike lack the heat conduction resistance coefficient in the certificates.
- According to the survey, all have certificates on the materials and products used, but the developers refuse to present them.
- In the larger part, new buildings are designed individually and are not subject to replication. In this regard the exceptions include the buildings 127/1-15 V. Antarayin of "Levon Aharonian" district, 10 buildings of the "Cascade Hills" multi-apartment complex (160/5 Antarayin) and "Glendale Hills" residential buildings (A-F). The developers mainly do not wish to have a repeated/replicated building, but at the

same time they note that from the constructive point of view, it is possible to repeat these buildings, with the implementation of different fronts.

- During the studies about half of the owners expressed willingness to cooperate with the Project. The other half do not wish to cooperate with the Project.

Recommendations

It is recommended to provide technical assistance for the partner developing organisations selected under the Project, on the following:

- Conducting energy audits of the building;
- Development/completion and provision of the building energy passport and certificate of the building;
- Support to the design of a residential building for the demonstration of the integrated design approach;
- Support to organisation of advertisements in the real estate market;
- Development and dissemination of electronic and printed booklets;
- Support to participation in training courses on the construction of energy efficient buildings; and
- Development and provision of a manual on the design, construction and operation of an energy efficient building.

ANNEX 1.

List of the Reports per the Works Performed in the Frames of the Project in the Reporting Period

"Shincertificate" LLC

- Report on Elaboration and Revision of Energy Efficienct Buildings Codes

"Architon" LLC

- Report on Design of Energy Efficient Residential Demonstration Building

"Third Nature" NGO

- Report on the Situation per Energy Efficiency in the Newly Constructed Residential Buildings in the Disaster Area

"Harsnadzor" LLC

- Report on the Implementation of Energy Efficiency Improvement Measures in the Demonstration Buidling in Goris Town

Lisa Surpernant

- Mission Report of the International Expert on Energy Efficient Buildings Design

Mark Chao

- Mission Report of the International Expert on Energy Efficient Buildings Codes

Apres Nazaryan

- Reports on Construction Supervision

Arsen Karapetyan

- Report on Elaboration/Revision of Energy Efficient Building Codes and Standards

Samvel Yedigaryan

- Study of Legal Status of Technical Regulations Applied in the RA Urban Development Sector and SNIPs Applied in Soviet Era and Localized in the RA, Comparative Analysis of Feasibility of Introduction of New Technical Regulations Meeting EU Requirements and Localization of SNIPs Applied in Soviet Era

Zaven Khudaverdyan

- Analysis of Considered Options for Energy Efficiency Improvement in the Selected Demonstration Building Design

Garegin Parsyan

- Report on Implementation of Design of Energy Efficienct Residential Demonstration Building

Khachik Sahakyan

- Report on Capacity Assessment of Construction/Thermal Insulation Materials a Testing Laboratories and Certification Bodies

Tigran Sekoyan

- Report on Assessment of Building Insulation Materials Certification Procedures and Development of Quality Assurance/Quality Control Systems in Production Facilities

Sergey Avagyan

- Report on institutional needs assessment for enforcement of energy efficiency requirements set forth in legislative and normative documentation in building design, construction and operation

Aram Julhakyan

- Report on needs assessment in legislative and normative field for enforcement of energy efficiency requirements in building design, construction and operation

Susanna Makaryan

- Report on Study and Assessment of Energy Efficiency in the Newly Constructed Buidlngs of the Republic of Armenia

ANNEX 2.

Analysis of thermal insulation materials/options observed within the task implementation

N	Option description	Applicability	Advantages	Shortcomings
1	Volcanic slag	Walls, the highest storey cover	Low price, local production	Growing damp, thick layers required to reach the desired coefficient, if used as wall filling gives shrinkage over time
2	Blown perlite	Walls, the highest storey cover	Local production	Can grow damp, if used as wall filling gives shrinkage over time
3	Polysterene (sheet)	Walls, the highest storey cover	Local production based on imported raw materials, relatively affordable price	Does not ensure solid external level, presents certain sanitary problems, burns (is not fire safe)
4	Polyurethane (blown directly on site)	Walls, the highest storey cover, the first storey cover	Ensures solid external layer, has sufficiently high thermal resistance coefficient, almost does not burn	Relatively new and little tested technology
5	Extruded polyurethane (sheet)	Walls, the highest storey cover	Has sufficiently high thermal resistance coefficient, does not burn	Too high value
6	Polysterene panels with metal network	Walls	Ready panels are installed easily, local production	Limited thickness (up to 10cm), high value
7	Perlite-concrete blocks	Walls	Local production, produced also for building coating	Limited thickness (up to 7cm), high value